



## Project: Make a Hovercraft You Can Ride!

(Do not attempt this activity without appropriate adult supervision! Be safe!)



Figure 1: Completed project

### Purpose

The purpose of this activity is to create a hovercraft you can ride. (See fig. 1.) In the process you will have to practice good safety habits, complete directions accurately, and apply the principals of friction for movement.

### Background

Have you ever felt like you were floating on air? Noooo, not because that special someone spoke to you by your locker this morning. I mean really floating on air! You can if you complete this activity. Get an adult and some classmates to help you build a real hovercraft. Learn how friction and air pressure can float you on air.

### Materials

- Safety gear: eye protection, hearing protection, dust mask, gloves, and any other safety gear required or recommended for the tools you use and the environment you are in.
- An electrically powered shop-type vacuum cleaner or leaf blower. You don't need the hoses or attachments, just the part that has the motor and the air inlet and outlet. You need something that has one simple air outlet. You'll be using it not as a vacuum, but as a blower to push air under your hovercraft. No matter what you use, we'll call this a "blower" for the rest of the instructions.
- A heavy extension cord rated for the blower you choose. **Caution!** *Inspect the entire length of your extension cord and the cord on your blower to make sure it is not cut or frayed. Be sure to use an extension cord with the correct rating. Also inspect the blower housing to ensure the housing isn't cracked and there are no exposed circuits or conductors.*
- 1 to 1 $\frac{1}{4}$  centimeter ( $\frac{3}{8}$  to  $\frac{1}{2}$  inch) thick plywood. You'll need enough to make a flat circle or disk at least 102 centimeters (40 inches) in diameter (1 centimeter and  $\frac{3}{8}$  inch plywood may need some additional wood pieces to act as stiffeners). **Caution!** *Any sharp edges must be filed down and wooden surfaces sanded to avoid dangerous edges and splinters. Any sharp points or rough edges that cannot be smoothed should be covered. This includes screws.*
- A chair that is less than or equal to 53 centimeters (21 inches) from the floor to the seat and does not recline, swivel, or roll. It will be securely anchored to the plywood base. Since it is likely to be a chair that you use in your home, be careful not to damage it when you attach it to the base.

- ▢ Polyethylene plastic sheet, at least 6 mil (1 mil =  $\frac{1}{1000}$  of an inch) thick, enough to cover the entire disk of plywood with at least 6 inches overlap all the way around the perimeter. It may be wise to get extra plastic. Color is not important.
- ▢ Utility knife or other utensil for cutting plastic. **Caution!** *When using a utility knife, always be sure the sharp edge is pointed away from anyone nearby, including the person doing the cutting.*
- ▢ An electrical switch. A power strip with a built-in switch is acceptable and easy to use for these purposes. You should tape over any outlets not used. This is so that the rider may have a quick, easily accessible on–off switch.
- ▢ Saw (a saber saw should be all that you need, but other saws will work as well). You MUST follow all the instructions for your saw(s).
- ▢ Sandpaper or foam sanding block.
- ▢ Plastic coffee can lid or whipped topping—or other similar thick plastic disk.
- ▢ Flathead wood screws (size will depend on how you design your hovercraft).  
**Caution!** *Any screw tips should be filed down and covered with silicone caulk to provide a rubbery safety cover.*
- ▢ Duct tape.
- ▢ Staple gun.
- ▢ Electrical tape.
- ▢ Scissors or a utility knife suitable for cutting the polyethylene.
- ▢ A rope or webbing, about 2.5 to 4 meters (8–12 feet) in length.
- ▢ Permanent marker
- ▢ Tape Measure.
- ▢ Canvas straps.
- ▢ Printed version of the “Make a Hovercraft you can ride!”
- ▢ Tie-wraps (optional).
- ▢ Silicone glue/caulk (optional).
- ▢ A single-hole office hole punch to punch holes in the polyethylene (optional) (a utility knife or hole punch for leather and a hammer will work as well).
- ▢ Foam pipe insulation (optional) for the circumference of the hovercraft disk.

## Procedure

1. **Safety first!**
  - A. Be sure to read and follow the safety requirements and recommendations for the tools you are using and those stated by the adult working with you.
  - B. Always wear eye protection when building your hovercraft.
  - C. Always wear ear protection when operating loud items such as saws.
  - D. Always wear dust masks when you are working with tools that generate dust.
  - E. Gloves should be worn when working with rough wood to help avoid splinters.
2. **Read all the directions and assemble all the materials before you begin.**
  - A. Be sure you understand the design of the hovercraft.

- B. If you decide to make the hovercraft larger or smaller, you will have to change some of the materials to be larger or smaller as well. Write out all those changes before you begin.
3. **Mark and cut out the plywood disk. Use the Saber saw.**
- A. A disk of at least 102 centimeters (40 inches) in diameter is recommended.
  - B. You want a large surface area disk to lift the weight, and you also want your hovercraft to have a wide base so it is stable.
  - C. Sand the edges to get rid of any roughness and splinters.
  - D. Pick one side to be the top, and one side to be the bottom.
4. **Mark and cut a hole in the plywood large enough for the blower exhaust.**
- A. This should not be in the center of the disk as you are going to cover the center later with the coffee can lid. It should be off to one side.
  - B. Also consider how your blower and chair will sit on the disk later and make sure the blower and chair will work without interference. (See fig. 2 and fig. 5.)
5. **Measure and draw a circle on the plastic sheet.**
- A. You need enough to cover the underside of the disk—with some slack—and then enough extra to wrap around and over the edge onto the top of the disk where you will staple it near the perimeter.
  - B. We recommend you make the plastic circle at least 15 centimeters (6 inches) in radius (30 centimeters or 12 inches in diameter) **larger** than the plywood disk. In other words, if your disk is 102 centimeters (40 inches) in diameter, your plastic circle should be at least 132 centimeters (52 inches) in diameter. You can always cut off the extra later.
  - C. You will be forming a bag out of the plastic and the plywood disk. You will not be pulling the plastic tight over the plywood.
  - D. The bag will fill up with air that will travel out a number of small holes you will cut in a later step. It is this air that will lift the hovercraft off the ground.
6. **Cut the plastic sheet to fit the plywood disk. Use the utility knife or other cutting utensil.**
- A. Turn the disk over so the bottom is facing up.
  - B. Place the circular plastic sheet over the plywood disk, lining up the centers.
  - C. Place the lid—the coffee can or whipped topping lid—over the center of both.



Figure 2: Hole for blower exhaust.

- D. With a permanent marker, trace a circle around the plastic coffee lid onto the plastic sheet.
- E. Draw a second circle on the plastic sheet about 7.5 centimeters (3 inches) smaller in radius than the outer edge of the plywood disk. (These circles can be quickly hand-drawn. They are only to show you approximately where to punch the small holes in the plastic.)
- F. Remove the plastic coffee lid.

7. ***Make the exit holes in the plastic sheet.***

- A. Using a single-hole office paper hole punch, a utility knife, or a hole punch for leather, punch or cut a number of small holes relatively evenly spaced over the surface of the plastic sheet in the area between the two circles. (You are creating the exit holes for the air to leave the hovercraft to lift you off the ground. If the exit holes are not evenly spaced, your hovercraft may lean too much to one side to work properly.)
- B. If you use an office hole punch, you can do this by creating small folds in the plastic just where you want to punch, pushing the fold  $\frac{1}{2}$  way or less into the punch, and then punching the hole. (If the hole punch method doesn't work, a utility knife or a leather punch and hammer may be used.)
- C. This may take some trial and error. In our unit, we used about 100 holes about the size of those in a loose-leaf piece of paper. The number and size you need may vary. If you don't cut enough holes, you can add some even after you've attached the plastic sheet to the plywood disk.
- D. You may also find that you need some additional holes closer to the edge of the plywood than the circle you drew in step 6. You can add more at any time.
- E. When someone is riding the hovercraft you don't want to see these small holes around the perimeter. If you can see them, then they are just wasting air by blowing it out to the side instead of using that air pressure to lift the hovercraft.
- F. If you use a utility knife, you should be careful not to scratch the table or floor you are working on. It is best to put a protective surface underneath. One suggestion is to cut the holes directly on the plywood disk.
- G. While the plywood needs to be smooth in general, you don't need to worry about light scratches in the surface of the plywood from the knife.

8. ***Design and build a mount for your blower.***

- A. Design a way to attach your electrically powered shop-type vacuum cleaner or leaf blower. (If you need additional materials, be sure to get them all together before you begin.)
- B. **CAUTION!** Most leaf blowers have a long nozzle that you may need to remove to fit the blower onto your hovercraft. When working with the blower with the nozzle removed, MAKE SURE the blower



Figure 3: Mounted blower.

is UNPLUGGED from the power source. If you do remove the nozzle from the blower, be sure the blower mount or other part of your design fully covers any exposed portion of the fan or impeller.

- C. Attach the mount to the top of the plywood disk. You can also do this step at other times, but this order allows you to use flat head screws from the bottom side of the disk to attach the blower mount (before you attach the plastic sheet).
- D. Depending on your design, you can either attach the blower to the mount and plywood disk now or do that later. (If you can design a mount that lets you attach the mount now and the blower later, it will make some of the remaining steps easier.)
- E. Use duct tape to seal any gap between the blower outlet and the plywood disk or blower mount. (See fig. 3.)

9. ***Attach the plastic sheet to the plywood disk.***

- A. Place the plastic sheet on the floor or table and place the plywood disk on top, with the top of the plywood facing up and the centers aligned.
- B. Wrap the plastic around the plywood disk and staple to the top of the plywood at the perimeter. (**CAUTION!** READ and FOLLOW the manual for your staple gun, including all safety notices. NEVER point the staple gun at anyone. Only use it when it is placed firmly up against the surface you are stapling.)
- C. Leave some slack. We recommend 1.2 to 2.5 centimeters ( $\frac{1}{2}$  to 1 inch) of extra plastic sheet along the radius all the way around the plywood disk as the plastic lays flat under the plywood. This too may require some trial and error.
- D. Place duct tape over the staples and edges of the plastic to seal this edge. (See fig. 4.)



Figure 4: Plastic sheet stapled and sealed to plywood disk (top view).

10. ***Create donut effect on plastic sheet.***

- A. Attach the coffee can lid to the center bottom of the disk with flathead wood screws. (See fig. 5.)
- B. Use at least 10 screws evenly spaced near the perimeter of the lid. This keeps the hovercraft more



Figure 5: Bottom view of blower exhaust hole and plastic lid that creates donut effect for plastic sheet.



evenly balanced by making the plastic bag into the shape of a donut when it inflates.

- C. We recommend you consider using a thin washer with each flathead screw to reinforce the attachment. The screw heads will stick out a bit further, but should still not interfere with the operation of your hovercraft.
- D. **CAUTION!** If the tips of your screws come through the top side of the plywood disk, cover the point with something to avoid injury. Silicone caulk or silicone glue can be used to make a rubbery protective cap.



Figure 6:  
Rope  
attached to  
blower or  
chair  
mount.

11. **Attach operator rope.**

- A. Attach a rope to a point on the top of the disk or the blower mount. (See fig.6.)
- B. The operator will use this rope to pull the rider along the floor.

12. **Attach the chair.**

- A. Attach the chair so that the rider's weight will be approximately located over the center of the disk. (See fig. 7 and fig. 8.)
- B. Remember that the rider and chair are probably going to be heavier than the blower, and you are trying to place the center of all the mass over the center of the hovercraft disk. If the chair is not centered well, then the hovercraft will be harder to move.



Figure 8:  
Canvas  
strap gives  
additional  
stability.



Figure 7: Chair legs  
are secured in wood  
blocks.

13. **Attach the emergency stop switch.**

- A. Attach the emergency stop switch to the chair where the rider will easily reach the switch. This will let the rider stop the hovercraft any time. (See figs. 9–12) **CAUTION!** Be sure the emergency stop switch and the power switch on the blower are both in the "OFF" position prior to connecting either to the power source.
- B. Connect the extension cord and blower to the emergency stop switch. If you are using a power outlet strip as shown in the photos, connect the blower motor cord to one of the outlets in the strip and the plug from the power strip to the extension cord.
- C. Use electrical tape to cover unused outlets in the power strip and tape, clips, or tie-wraps to secure the cords to the hovercraft.



Figure 9: Mount for emergency stop switch.



Figure 11: Extra wrapped and properly secured to chair.



Figure 10: Taped and secured emergency stop switch for rider.



Figure 12: Correctly positioned emergency stop switch.

14. ***Anchor and stabilize rope and extension cord.***

- A. Anchor the extension cord to the hovercraft near the attachment point for the rope, using clips or tie-wraps. (See fig. 13.)
- B. Lay the rope and the cord out on the ground along side each other.
- C. Pull the rope tight and tape the extension cord to the rope every 45 centimeters (2 feet), leaving some slack in the extension cord. (See fig. 14.)
- D. This will allow you to move the hovercraft by pulling on the rope and not straining the extension cord.
- E. The operator will stand about 1.2 to 3 meters (4 to 10 feet) away from the hovercraft and pull on the rope to move the hovercraft.



Figure 13: Extension cord for blower secured properly to plywood disk.



Figure 14: Rope and extension cord secured; rope pulled tight to maneuver hovercraft.

15. **Test your hovercraft without a rider.**

- A. Clear an open, dry, flat space. A garage floor works well.
- B. Test your hovercraft with no one riding it. (See fig. 15.)
- C. See that it lifts off the floor and floats about as the operator pushes on it or pulls on the rope.
- D. Test the emergency stop switch to turn the hovercraft off.
- E. **CAUTION!** Never suddenly stop, start or redirect the motion of the hovercraft as it glides across the floor. Always move the hovercraft slowly across the floor and gently stop, start, or redirect it.
- F. **CAUTION!** Never ride or test the hovercraft in a wet or damp area.
- G. **CAUTION!** Be sure the entire length of the electrical power cord, from the hovercraft to the power outlet, is also in a completely dry area as well.
- H. **CAUTION! Always have an adult present when operating the hovercraft.**



Figure 15: Test of completed hovercraft without rider.

16. **Test your hovercraft with a rider.**

- A. If it looks like it's working fine, turn the hovercraft off and have the first rider get onboard.
- B. Only one rider should ride the hovercraft at once.
- C. The adult operator should turn on the blower and then give the hovercraft a slight push.
- D. The rider should see if the craft is balanced—or which way the chair should be moved to balance it.
- E. If the hovercraft seems unbalanced, stop the power and get off the hovercraft.
- F. Move, reattach the chair, and try again.
- G. **CAUTION!** The rider should ALWAYS be sitting in the chair during the hovercraft operations.

17. **You may add extras for a better ride.**

- A. You may wish to put some padding around the outer edge of the hovercraft disk. Foam pipe insulation works well for this. Just staple it around the perimeter, over the top of the plastic.
- B. You may want to tie a second rope to the hovercraft so that a second operator can pull from the opposite side of the first operator.



- C. **Caution!** Again, only move the hovercraft across the floor at low speed. Do NOT stop, start, or redirect the hovercraft suddenly. The rider should ALWAYS be sitting in the chair during the hovercraft operations.



Figure 16: Fully operational hovercraft.



Figure 17: Fully operational hovercraft, back.

**Congratulations. You've just designed and built your very own hovercraft!**

## Hovercraft Activity Checklist

<b>Steps to Make a Hovercraft You Can Ride</b>	<b>Date/Time Started</b>	<b>Date/Time Completed</b>
1. Safety first!		
2. Read all the directions and assemble all the materials before you begin.		
3. Mark and cut out the plywood disk.		
4. Mark and cut a hole in the plywood large enough for the blower exhaust.		
5. Measure and draw a circle on the plastic sheet.		
6. Cut the plastic sheet to fit the plywood disk. Use the utility knife or other cutting utensil.		
7. Make the exit holes in the plastic sheet.		
8. Design and build a mount for your blower.		
9. Attach the plastic sheet to the plywood disk.		
10. Create donut effect on plastic sheet.		
11. Attach operator rope.		
12. Attach the chair.		
13. Attach the emergency stop switch.		
14. Anchor and stabilize rope and extension cord.		
15. Test your hovercraft without a rider.		
16. Test your hovercraft with a rider.		
17. You may add extras for a better ride.		

